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HABITAT USE AND BEHAVIOR OF MALE MOUNTAIN SHEEP IN FORAGING ASSOCIATIONS WITH WILD HORSES

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Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) maximize survival by foraging in secure habitats that afford high visibility and have good interspersion of preferred forage plants with escape cover (Risenhoover and Bailey 1985). Good visibility and precipitous escape cover are structural habitat elements that provide mountain sheep with security from predators (Buechner 1960, Geist 1971, Wishart 1978, Risenhoover and Bailey 1985).

Wild horses (*Equus caballus*) also maximize survival by foraging in secure habitats with good interspersion of preferred forage plants. However, different structural elements of the habitat provide security for mountain sheep and horses; mountain sheep select foraging areas near precipitous escape terrain while horses select foraging areas near open, flat terrain. This is due to basic differences in predator escape tactics for the species: mountain sheep climb to avoid predation and horses run.

Although grasses dominate the diets of both horses and mountain sheep, each species' predator-avoidance strategy selects for structurally different habitats. However, when spatial distributions overlap, a competitive situation may occur, with mountain sheep being negatively impacted. In several instances such competition with feral equids has resulted in mountain sheep declines (McMichael 1964, Weaver 1973, Seegmiller and Ohmart 1981).

A growing body of literature supports the hypothesis that horses and other exotics may, in some respects, facilitate the foraging effectiveness of some native ungulate species either by habitat modification or increased protection from predators (Berger 1978, 1986, Festa-Bianchet 1991). The purpose of this note is to present unique observations which suggest that male mountain sheep may benefit from close foraging relationships with wild horses. Few data exist on resource competition between mountain sheep and feral horses (Berger 1986), and though not statistically quantifiable, these limited observations support Berger's (1986) hypotheses regarding forage facilitation of native species by exotics.

Study Area and Methods

The study was conducted at Bighorn Canyon National Recreation Area (BICA), a 48,679-ha National Park Service unit that has as its focal point a 114-km-long reservoir in southeastern Montana and north central Wyoming. Mountain sheep recolonized BICA in 1975 because of dispersal of 4–6 animals from a nearby transplant. By 1986 the population had increased to over 60 animals (Coates and Schemnitz 1986).

Portions of BICA are federally designated as the Pryor Mountain Wild Horse Range (PMWHR). The 17,402-ha PMWHR supports approximately 120 wild horses and is located 80 km south of Billings, Montana (Bureau of Land Management 1984).

The area is characterized as a desert-shrub woodland (Lichvar et al. 1985), and dominants include a sparse overstory of curlleaf mountain mahogany (*Cercocarpus ledifolius* var. *intercedens*), Utah juniper (*Juniperus osteosperma*), sagebrush (*Artemisia* spp.), and greasewood (*Sarcobatus* spp.), with a poorly developed understory of bunchgrasses (Lichvar et al. 1985). Annual precipitation averages

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15–20 cm. Soils present include limestone and sandstone in the precipitous canyonland and dolomite in the nonprecipitous areas (Knight et al. 1987). Elevations vary from a mean pool level of 1109 m at the reservoir to 2682 m at East Pryor Mountain.

Gray limestone cliffs rise >250 m vertically from the lakeshore. Cliff faces, ledges, and eroded limestone soils (karst topography) provide abundant escape terrain for mountain sheep. Escape terrain predominates the entire study area, from East Pryor Mountain to the reservoir. Other than an alluvial fan located at the northern extreme of the study area, virtually all habitat is within 300 m of cliffs, ledges, or karst topography (Coates 1988).

Three adult ewes (>18 months old) and a 6-year-old ram were captured and equipped with radio collars manufactured by Telonics (Mesa, Arizona). Systematic radio relocation of these animals provided the opportunity to locate and observe 328 groups of mountain sheep between June 1986 and November 1987.

Group size and age/sex composition were recorded for each observation. Additionally, three habitat parameters were analyzed: horse use (Yes/No), distance to precipitous terrain, and vegetation type. A preference ratio (percent use/percent availability) was used to analyze preference and/or avoidance of vegetation types (Risenhoover and Bailey 1985). Because escape terrain was nearly continuous throughout the southern portion of the study area (distance rarely >300 m), all habitat types were considered available to mountain sheep. The alluvial fan was considered available to mountain sheep, primarily to investigate differences in habitat selection between male and female cohorts of mountain sheep, and to analyze the influence of distance to escape terrain on foraging behavior.

The foraging behavior of adult mountain sheep was analyzed to determine the effects of habitat security on foraging efficiency (Risenhoover and Bailey 1985). Once a group of mountain sheep was located, a focal animal was selected for analysis of foraging behavior. Recognition of focal animals was aided by identifying marks on pelage or scars. Foraging behavior was observed for five consecutive 3-min periods to determine the amount of time the focal animal devoted to three behavioral categories: foraging, social, alert (Risenhoover and Bailey 1985). An animal was engaged in foraging when it actively ingested forage and when it moved about with animals that were actively ingesting forage.

An animal was engaged in social behavior for all intraspecific and interspecific interactions. Social interactions included looking at another animal, moving toward/away from another animal, and mother/young interactions. Alert behavior was recorded if the focal animal stopped foraging to look up in the typical alert posture for mountain sheep (i.e., ears up and neck outstretched; Geist 1971), if it looked at a disturbance (e.g., a vehicle on the highway, or a person approaching on foot), or when it ran to avoid a disturbance (e.g., a person approaching on foot). Foraging efficiency was calculated as percentage of time devoted to foraging behavior during the 15-min period. Percentage of time spent in alert or social interactions provided a measure of the relative security of mountain sheep in different habitats.

Results and Discussion

Four vegetation types (Knight et al. 1987) occur within the observed range of mountain sheep: Utah juniper/mountain mahogany woodland (JU/CE), Utah juniper woodland (JUOS), mountain mahogany woodland (CELE), and Douglas fir woodland (PSME). Distribution of JUOS was limited to an alluvial fan at the north end of the study area and narrow fingers interspersed within the JU/CE habitat type. Horse use was always "No" for karst topography and "Yes" for the alluvial fan at the northern extreme of the study area, based on the presence/absence of horse feces observed during fieldwork. Horse use was also observed along fingers of nonprecipitous habitat interspersed throughout the JU/CE type. Distribution of PSME was restricted to a deeply incised drainage present in the core use area occupied by rams.

Overall, 85.7% of male mountain sheep observations involving mixed age/sex groups occurred in JU/CE woodland. JUOS, CELE, and PSME woodlands were used in 13.6, <1, and <1% of the observations, respectively (Table 1). The preference ratio for JU/CE is 4.5, indicating that mountain sheep foraging with conspecifics prefer this type (Risenhoover and

TABLE 1. Percent habitat utilization by male mountain sheep in foraging associations with conspecifics compared with associations with wild horses. Habitat preference ratios are expressed as + or – and are given in parentheses below each appropriate category.

	Habitat Type			
	JUOS	CELE	JU/CE	PSME
Male mountain sheep:				
With conspecifics	85.7	13.6	<1	<1
Habitat preference	(+)	(–)		
With wild horses	16.7	83.3	0	0
Habitat preference	(–)	(+)		

Bailey 1985). Preference for JU/CE habitat probably resulted more from the interspersion of escape terrain than from differences in visibility between habitats. Juniper was sparsely distributed throughout both JU/CE and JUOS types. Distinction between types was based on occurrence of curlleaf mountain mahogany rather than on increasing frequency of Utah juniper (Lichvar et al. 1985). Visibility obstruction was low in both JU/CE and JUOS habitats. Ewes never occupied the PSME type, even though it was located on rocky slopes, because visual obstruction was much higher than in JU/CE or JUOS.

Male mountain sheep were observed foraging with wild horses 22 times on 20 different days, and habitat parameters were recorded for 12 observations. Foraging associations usually involved 2 specific male horse/harem groups with bachelor ram groups. Ram group size ranged from 3 to 7 animals, 3 to 10 years of age. Female mountain sheep were never observed in association with wild horses. Horse group size was dynamic, but association usually involved 1 of 2 specific male horses accompanied by 5 to 8 mares and subadults. Of the 12 observations, 83.3% (n = 10) occurred in the JUOS vegetative type, and 16.7% (n = 2) occurred in JU/CE (Table 1). The preference ratio for JUOS is 1.2. The preference ratio for JUOS by male mountain sheep foraging with wild horses is noteworthy because habitat utilization patterns for JU/CE and JUOS were reversed when male mountain sheep associated with wild horses (Table 1).

These limited observations suggest that male mountain sheep foraging with conspecifics may prefer the JU/CE vegetation type, but male mountain sheep foraging with wild horses may prefer JUOS. Conversely, male mountain sheep foraging with conspecifics avoided JUOS, but male mountain sheep foraging with wild horses avoided JU/CE.

Grasses accounted for <1% of the vegetative cover in the JU/CE type but approximately 6% of the JUOS type (Knight et al. 1987). Although grasses were present in low composition in both vegetation types, mountain sheep foraging in JUOS had a higher availability of grasses.

Average distance to escape terrain was determined for male mountain sheep that foraged with conspecifics and compared to the distance for male mountain sheep that foraged with wild horses (Table 2). Male mountain sheep foraging with conspecifics remained within an average of 47 m (SD 69.5 m) from escape terrain, partially because of the ewes' reluctance to venture farther than 50 m from secure habitat. However, male mountain sheep foraging with wild horses were an average of 217 m (SD 310 m) from escape terrain. These limited data suggest that male mountain sheep foraged farther from escape terrain (in less secure habitat) when associated with wild horses than with conspecifics.

Foraging efficiency of mountain sheep with wild horses was 100% for all 12 locations (no alert or social interactions). Male mountain sheep that foraged with wild horses ignored disturbance (e.g., they could be approached readily, and they rarely looked up to scan their surroundings even when horses were fighting in their vicinity). Group size ranged from 9 to 16 animals, including rams and horses. Foraging efficiency of male mountain sheep with conspecifics was only 66% (n = 67) and was characterized by high levels of aggressive or social interaction (Table 3). Aggressive interactions were exhibited between rams when two or more followed a ewe, and when they established dominance rank in the male cohort. Social interactions between rams occurred when they attended ewes. Aggressive or social interactions were never observed when male mountain sheep foraged with wild horses. This may have been due to size-related dominance in mountain sheep (Geist 1971) and subordinate behavior of male mountain sheep in the presence of the relatively large wild horse (Berger 1986).

TABLE 2. Average distance to escape terrain (m) of male mountain sheep in association with conspecifics compared to distance when associated with wild horses. Standard deviations shown in parentheses.

	Distance to escape terrain (m)
Male mountain sheep:	
With conspecifics	47 (SD 69)
With wild horses	217 (SD 310)

TABLE 3. Average foraging efficiency of male mountain sheep in foraging associations with conspecifics compared with associations with wild horses.

	Percentage of time devoted to three activities while foraging		
	Foraging	Social	Alert
Male mountain sheep:			
With conspecifics	66	32	1
With wild horses	100	0	0

The subordinant/dominant relationship between male mountain sheep and wild horses was suggested both by the sheep's lack of aggressive behaviors while foraging and by the behavior of male wild horses directed toward male mountain sheep. Male wild horses were observed herding, or driving, male mountain sheep ($n = 3$) in a manner similar to the typical posture used when herding females (Feist 1975, Berger 1986). This typical herding posture consisted of running toward a female horse, or in this case a male mountain sheep, with ears flattened against the head, neck outstretched, and head held low to the ground.

Another indication of the subordinant/dominant relationship between mountain sheep and wild horses was extended penis behaviors that Feist (1975) described as a mechanism to establish dominance in wild horse groups. These extended penis behaviors were directed by a subordinant male wild horse (without harem) to a 9-year-old male mountain sheep with three other rams ages 3 to 7. There were no other horses in the vicinity. By exerting dominance over male mountain sheep or allowing rams to enter their harem, stallions can potentially elevate their own dominance rank and subsequent reproductive success by attracting additional females.

In summary, we believe that, contrary to some literature (McMichael 1964, Weaver 1973, Seegmiller and Ohmart 1981), male mountain sheep and wild horses can have beneficial relationships. Habitat selection by mountain sheep is a complex function of season, age, reproductive status, and sex of the animal (Smith 1992). This paper presents analyses suggesting that habitat selection and foraging efficiency may also be influenced by association with another species during foraging periods. These data support Berger's (1986) hypothesis that feral horses may perhaps serve either as competitor or as facilitator, depending on ecological conditions. In this case they served as competitor for a patchy supply of grasses, but possibly also as facilitator by increasing foraging efficiency in insecure habitat. Dominance rank of male horses may have increased as a result of the relationship. Sample sizes were small, but these unique observations suggest that male mountain sheep in association with wild horses foraged farther from escape terrain, enabling them to use areas that supported higher composition of grasses than areas used with conspecifics. Also, male mountain sheep did not exhibit aggressive behaviors while in association with wild horses and thus had higher foraging efficiency than those with conspecifics. To the best of our knowledge, foraging associations of this type have not been previously reported.

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